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(54) **CASTING OF TANK**

VERFAHREN ZUM FORMEN EINES BEHÄLTERS

MOULAGE D'UN RESERVOIR

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Description

FIELD OF INVENTION

[0001] The present invention generally relates to casting concrete elements together and particularly to casting prestressed concrete elements together into a tank.

BACKGROUND

[0002] There is today a need of a tank, which is easy to assemble. It is easier and less labour-intensive to guide pre-stress cables internally in concrete elements than externally through holes in ribs, by using mechanical equipment, so-called push-through machines. Further, the risk is less that the pre-stress cables break or are cut off through sabotage, if the pre-stress cables run inside the concrete elements instead of outside the concrete elements.

[0003] Prestressed concrete elements for tanks are described in EP 0514583 (Parenti) and in BFT No. 4/89 "Concrete precasting plant and technology", pages 90-93 by Josef Imkamp. A circular tank, comprising prefabricated concrete elements, is disclosed in DE 3335141.

[0004] Prestressed concrete elements are normally manufactured in whole parts. When these later are cast together to a tank, which should be able to contain e.g. liquid without leaking, on one hand prestressed cables are used to keep the concrete elements together and on the other hand the joints between the concrete elements are cast together. The pre-stress cables running through the concrete elements are guided through embedded tubes, e.g. plastic tubes. The pre-stress cables need to be protected against corrosion, which among other things implies that they should not have contact with air. In order to protect the pre-stress cables against corrosion they are provided with a plastic cover containing grease.

[0005] The joint between two concrete elements needs to be shaped to solve several problems. Because the tank is formed of straight concrete elements, the pre-stress cables will, when guided around the tank, risk getting stuck in the joints, unless they are guided straight to the next pipe inlet. The joints between the concrete elements are at assembly not solid in themselves, which they suitably should be, since joint concrete to be cast in the joints is very fluent. If having problems with regular casting of the joints it could be necessary to separately re-cast each joint individually. It is complicated to cast from above and simultaneously get rid of air that could weaken the cast.

SUMMARY OF THE INVENTION

[0006] An object of the present invention is to manufacture a solid tank.

[0007] Another object of the present invention is to manufacture a tank, where protection against corrosion and mechanical damage of the pre-stress cables is improved.

[0008] Still another object of the present invention is to manufacture concrete elements with vertical sections facilitating mechanical joint cast from below and up by means of a pump.

[0009] Yet another object of the present invention is to manufacture a tank with improved structural strength.

[0010] In accordance with the present invention there are provided a tank according to the characteristics in claim 4 and a concrete element for a tank according to the characteristics in claim 1.

[0011] In order to further protect the pre-stress cables against corrosion, the embedded tubes guiding the pre-stress cables are also filled with joint concrete when casting the joints.

[0012] In order to prevent air pockets from arising when filling joint concrete a method is utilized, where a first joint starts filling up and after a time delay filling of the closest joints on each side of the first joint starts. After another time delay filling of the subsequent joints starts and so on until filling of all joints have started. By casting the joints together a solid tank is obtained.

[0013] The plastic tubes used to guide the pre-stress cables around the tank inside the concrete elements has a funnel-shaped design at one end in order to easier be able to receive the pre-stress cable in that end when it is guided around the tank.

[0014] Sealing devices are preferably inserted in the outer parts of the joint in order to prevent the joint concrete from leaking at casting.

[0015] The cavity or transcend hole positioned at the side of the horizontal tubes and of the track of the pre-stress cable is intended partly for conveying the joint concrete at casting of the tank and partly as a safety channel for manual filling of joint concrete if something should go wrong at the ordinary filling of joint concrete.

[0016] Further features and advantages of the present invention will be evident form the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying figures, which are given by way of illustration only, and thus, are not limitative of the present invention, wherein:

Fig. 1 shows a tank with a pump for filling of joint concrete;

Fig. 2 shows a part of a pipe line system for filling of joint concrete in a tank according to a preferred embodiment;

Fig. 3 shows a float for marking that a joint is filled;

Fig. 4 shows a cross-section through a joint between

two concrete elements; and

Fig. 5 shows a system for filling of joint concrete into a tank according to another embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0018] In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed description of well-known methods and apparatuses are omitted so as not to obscure the description of the present invention with unnecessary details.

[0019] The invention will now be described by illustrative examples with reference to the figures.

[0020] First, a preferred embodiment will be closer described.

[0021] A tank 100 comprising nineteen concrete elements 103 is shown in Fig. 1. Further, a pump 101 and a pipe line system 102 connected to each joint 1-19 are shown. Each concrete element 103 comprises a plurality of embedded tubes 42, plastic tubes, which are intended to guide pre-stress.cables 43, e.g. steel cables, around the tank 100. The pre-stress cables 43 are used to keep the concrete elements 103 together, when the joints 1-19 are cast together. In order to be able to obtain an even filling, without air pockets, of joint concrete in all joints 1-19 and in all embedded tubes 42 in a tank 100 a method is used, where the filling up of joint concrete is at first filled in joint 1. After a time delay filling of joints 2 and 3 is started and then after still another time delay filling of the joints 4 and 5 starts, and so on until filling of all joints 1-19 with joint concrete has started. The joint concrete is filled from the lower edge of the joints under pressure.

[0022] A pump 101 and pipe lines 102, for distribution of joint concrete under pressure, are lifted into the tank 100. A system of pipes, Fig. 2 showing a part of the pipe system, for distribution of the joint concrete to the different joints 1-19 is put together so that a first pipe leads from the pump 101 to a three-way fork 20 close to the concrete elements 103. The two subsequent pipes in the three-way fork 20 leads further around the inside of the concrete elements 103. At each joint a three-way fork 20 is placed, which leads further around the inside of the concrete elements and into a nozzle in the joint. At each joint a valve 21 is placed, e.g. a ball valve or a sliding valve, which is used as a cut-off valve 21 for each respective joint. Further, valves 22 are shown, such as e.g. ball valves, positioned in the pipe system 102 between the respective joint 1-19 and used for time delaying the start of supply of joint concrete into the different joints 1-19.

[0023] When the pump 101 shown in Fig. 1 is started and mixing of the joint concrete begins, the pump 101 is disconnected from the pipe system 102, all valves 22 between the respective joint 1-19 is closed and all non-return valves 21 is open. When the joint concrete in the pump 101 is of an acceptable quality, the pump 101 is mounted together with the pipe system 102 and the joint concrete is pushed out into the pipe system 102. First, the joint concrete arrives to a three-way fork 20 and, since the valves 21, 22 are set in such a way, is led to the first joint 1. The joint concrete is led into each joint through an embedded bent pipe. The bent pipe is embedded in the lower edge of the concrete elements 103. The joint concrete fills the joint 1 and the pipes 42, which are used to guide the pre-stress cables 43 to the adjacent concrete elements, and when the joint concrete reaches the upper edge of the joint 1 a float 34, shown in Fig. 3, rises indicating that the first joint 1 is filled. The float 34 is arranged in an upper sealing and is further used to prevent the joint concrete from leaking out.

[0024] A lower sealing of the joints is effectively obtained if casting is performed around the bottom of the concrete elements, otherwise a temporary sealing has to be obtained, which is performed by inserting a sealing device held up against the bottom of the joint with wedges.

[0025] For the air in the system being able to depart there are holes around the floats in each joint. As the float 34 rises due to the joint concrete reaching the joint 1 there is a sealing ring 33 on the float 34, which seals against the upper part of the joint 1 and prevents the joint concrete from leaking out. When the float 34 rises and seals the upper part of the joint 1, it is an indication that the joint 1 is filled. The uppermost part 35 of the float 34 could e.g. be painted in order clearly to indicate when it moves upwards.

[0026] The air in the system should also be able to depart from each embedded tube. For this to be possible each embedded tube is provided with a ventilation pipe 105 at the holes where the pre-stress cables are guided into the concrete elements. The ventilation pipes 105 emerge at the inside of the tank 100. Each ventilation pipe 105 is provided with a cut-off valve, e.g. a ball valve. When the joint concrete comes out through a ventilation pipe 105, it indicates that the pipe is filled and its cut-off valve is closed.

[0027] An alternative method to bring the air to depart from each embedded tube is to utilize small holes instead of ventilation pipes. With a small hole, having a diameter of approximately 3 mm, air and water will depart from the embedded tubes, while the concrete remains.

[0028] After a delay of a couple of minutes after the first joint 1 having started to fill up the two valves 22 are opened admitting the joint concrete further to the joints 2 and 3. After still another delay of some minutes the valves admitting the joint concrete further to the joints 4 and 5 are opened, etc. This goes on until the joint concrete has started to fill all the joints 1-19. As the floats 34 in the upper part of the joints rises and indicates that each

respective joint is filled, each respective non-return valve 21 is closed. The closing of the non-return valves 21 takes place with a certain delay. When the joints 2 and 3 have been indicated to be filled, and also the joint 1, the non-return valve 21 at the joint 1 is closed. This prevents the joint concrete form sinking back. Then, as the next float indicates that its joint is full, the non-return valve 21 belonging to the adjacent joint, the float of which has earlier indicated a filled joint, is closed. When finally all floats indicate that their respective joint is filled, all valves 21, 22 are closed.

[0029] If a problem should arise preventing complete casting of the tank 100, the joints could be filled afterwards. By lowering a pipe into the transcend hole 41 and filling joint concrete from above continuing where the incomplete casting ended, and rising the filling pipe as the joint concrete rises, air pockets can be avoided.

[0030] The pipe system is now disassembled and cleaned, which implies that it could be re-used.

[0031] Fig. 4 shows a cross-section through a joint between two concrete elements 103. The joint is designed to be able to guide pre-stress cables 43 safely past the joint when the pre-stress cable 43 is led around the tank 100. The pipe 42 guiding the pre-stress cable 43 in the direction towards the insert, out of the joint into the subsequent concrete element, of the pre-stress cable 43 has a funnel, which catches the pre-stress cable 43. The pipe 42 guiding the pre-stress cable into the joint is intended to be aligned with the pipe 42, which guides the pre-stress cable out of the joint. If at the manufacture of a concrete element a pipe ends up a little askew the above-mentioned funnel is especially important, as at the assembly a pre-stress cable therein is not guided straight to the inlet of the next pipe.

[0032] To prevent joint concrete from leaking out at the filling of joint concrete sealing devices 40 are positioned, e.g. precompressed compress bands or a sealing compound, in the outer parts of the joint and sealing plates are fastened in the upper and lower edges of the joint. This additional sealing device 40 is preferred, since the joint concrete is supplied under pressure. Further, a cavity (transcend hole) 41 is formed beside the paths of the pre-stress cables 43 in order for the joint concrete being able to rise in the joint space and fill out also the pipes 42 with joint concrete (each concrete element has a plurality of pipes 42 distributed on different levels in dependence on the height of the concrete element). The positioning of the transcend hole 41 beside the path of the pre-stress cable is important if a problem should arise during casting. In order to be able easily to continue the casting of the tank 100, even if part of the joint concrete has already been filled into the tank 100, a pipe can be put down into the transcend hole 41 and joint concrete be filled from the upper part of the joint but still joint concrete is filled from below (continuing where the casting was interrupted). If the transcend hole 41 was positioned at the pre-stress cable a pipe would not be able to be put down the transcend hole.

[0033] The distance between the concrete elements at the transcend hole 41 is larger than the distance at the pre-stress cable 43, in order to minimize the amount of joint concrete that is needed for casting the tank. The transcend hole 41 preferably has a diameter of approximately 40 mm, for receiving joint concrete from below or refill pipe from above. The distance between the concrete elements at the pre-stress cables is preferably 10-15 mm, which besides minimizes the amount of joint concrete facilitates guiding of pre-stress cables through a joint. Further, the joint has sockets for allowing easy insertion of sealing devices 40, and protruding and respective recessing parts that engage each other that keep the concrete elements positioned during assembly. The protruding and recessing parts are convex respectively concave, which lessen the strain from the pre-stress on the concrete elements.

[0034] The float 34 used to prevent the joint concrete from emerging out of the upper edge of the joint and used to indicate a filled joint is closer shown in Fig. 3. The float comprises a plastic tube with a sealing 31 at the bottom side, which prevents the joint concrete from leaking through the pipe and instead involving that the pipe rises, when the joint concrete rises to the top in the joint. Around the pipe the air is allowed to be pushed out; it is pushed out by the inpouring joint concrete. Further, the pipe has a sealing ring 33, which seals the space letting out the air, so that the joint concrete will not leak out when it reaches the top of the joint. The sealing ring 33 is kept in place by a container 32. When the float 34 rises, a flag 35 is raised, i.e. the end of the pipe, which e.g. could be painted, and indicates that the joint is filled.

[0035] Another embodiment will now be described more closely with reference to Fig. 5.

[0036] In this embodiment, the joint concrete is guided into the concrete elements through only one inlet pipe 23. This pipe preferably guides the joint concrete through joint 1, opposite to the concrete element with the ventilation pipes 105. In this embodiment an additionally coarse embedded tube is utilized in the lowermost part of the concrete elements to allow the joint concrete to easily be spread to all the concrete elements. After the lowermost pipe having been filled, the joint concrete rises in joints 1-19 in the same manner as has been described above without any valves needing to be opened. This embodiment does not utilize feeding valves except at the only inlet pipe. In the same way as described above ventilation valves are closed as the joints are filled.

[0037] Using this method the only pipe system necessary in order to distribute the joint concrete between the joints is that inside the concrete elements, and the pump can be positioned quite close to joint 1. With the need of only one inlet pipe this pipe could be positioned outside the tank and a pump will not be required to be lifted inside the tank but could instead be connected from the outside of the tank. As a precautionary measure additional inlet pipes 24 can be positioned for instance at joints 12 and 13. If the pump is located outside the tank, the ventilation

pipes are also directed out from the tank. As the entire system shall be filled from one point, a higher pressure will be needed, which puts a higher demand on the sealing devices. In order to reduce the pressure backwards in the system it is possible to utilize non-return valves in the joints 1-19 between different levels, e.g. where the pipes guiding the pre-stress cables are distributed.

[0038] A non-return valve can e.g. simply be a horizontal lid, which is articulated at the one end and movable upwards from the vertical plane at its other end and also with a stopping device, which prevents the movable part from moving downwards from the vertical plane. The pressure from the pump lifts the lid upwards and if the pressure should be greater from above the lid falls back and prevents the joint concrete from pouring back in the system.

[0039] In a further embodiment, not shown, the pipe system is built up so that a single person inside the tank could handle it. After the pump a three-way fork is positioned and on each further fork another three-way fork is placed. Each further fork has valves, e.g. ball valves, used to control the flow of joint concrete to each separate joint. The filling of joint concrete takes place as according to the embodiment mentioned before but with the difference that the stopping of flow can now be performed with the same valve that opened the flow of the joint concrete. The non-return valves are closed after the entire casting process having been completed and all the joints are filled with joint concrete.

[0040] Systems of the above kind may of course be easily automated. Instead of a flag being mechanically raised when a joint is filled a sensor could give a signal, e.g. an electric impulse, to a control unit which further controls the valves, which after a suitable time delay stops further filling of joint concrete. And the same control unit could control the pump and valves to open as well as to close.

[0041] In a preferred embodiment the concrete elements of the tank are prestressed both vertically and horizontally. Vertically prestressed concrete elements are obtained by molding pre-stress cables into the concrete elements during manufacturing. Horizontally prestressed concrete elements are obtained as described above. By pre-stressing the concrete elements in both horizontal and vertical direction, a strongly improved structural strength is achieved. Elements for higher tanks, i.e. longer elements when cast, are more robust when handled. Such vertically prestressed elements are less sensitive to gradient forces, such as temperature differences or horizontal pre-stress. Further, the vertical pre-stress cables are embedded in the concrete elements, while the horizontal pre-stress cables are anchored on one of the concrete elements.

[0042] It will be obvious that the present invention may be varied in a plurality of ways. Such variations are not to be regarded as departure from the scope of the present invention. All such variations as would be obvious for a person skilled in the art are intended to be included within the scope of the present invention as defined in the claims.

Claims

1. A concrete element (103) for a tank (100), said element comprising embedded horizontal tubes (42) arranged to receive pre-stress cables (43), wherein said element is formed such that when two elements are positioned side by side a joint space for casting the two elements together is defined between them, **characterized by**
said joint space comprising a cavity (41) beside said horizontal tubes (42), for rising of joint concrete and lowering of a filling pipe, wherein in said joint space the distance between the two concrete elements is larger at said cavity than at said horizontal tubes (42).

2. The concrete element as claimed in claim 1, wherein sealing devices (40), preferably precompressed compress bands, are positioned in the outer parts of said joint space.

3. The concrete element as claimed in claim 1 or 2, wherein one side of said element comprises a recess and an opposite side of said element comprises a protruding part, which sides are formed such that, when two elements are positioned side by side the protruding part of one of the elements engages the recess of the other element.

4. A tank (100) comprising a plurality of concrete elements (103) cast together, said concrete elements being vertically pre-stressed and having horizontally embedded tubes (42) containing horizontal pre-stress cables (43), wherein said embedded tubes and the joints between the concrete elements positioned side by side are filled with joint concrete, said tank being **characterized in that** said concrete elements are formed such that each of the joints has a concrete filled joint space comprising a cavity (41) beside said horizontal tubes containing pre-stress cables (43), in which said joint concrete has been filled, and in each concrete filled joint space the distance between two adjacent concrete elements is larger at said cavity than at said horizontal tubes.

Patentansprüche

1. Betonelement (103) für einen Tank (100), wobei das Element eingebettete waagrechte Rohre (42) aufweist, die zum Aufnehmen von Vorspannungskabeln (43) angeordnet sind, wobei das Element so ausgebildet ist, dass bei einer Anordnung von zwei Elementen nebeneinander ein Fugenzwischenraum zum Zusammengießen der beiden Elemente zwi-

schen ihnen definiert ist,
dadurch gekennzeichnet, dass
der Fugenzwischenraum einen Hohlraum (41) neben den waagrechten Rohren (42) aufweist, um einen Fugenbeton ansteigen zu lassen und ein Einfüllrohr nach unten einzuführen, wobei im Fugenzwischenraum der Abstand zwischen den beiden Betonelementen am Hohlraum größer als an den waagrechten Rohren (42) ist.

2. Betonelement nach Anspruch 1, wobei Abdichtungsvorrichtungen (40), vorzugsweise vorkomprimierte Kompressionsbänder, an den äußeren Teilen des Fugenzwischenraums angeordnet sind.

3. Betonelement nach Anspruch 1 oder Anspruch 2, wobei eine Seite des Elements eine Vertiefung und eine gegenüberliegende Seite einen vorstehenden Teil aufweist, wobei die Seiten so ausgebildet sind, dass beim Anordnen von zwei Elementen nebeneinander der vorstehende Teil des einen der Elemente mit der Vertiefung des anderen Elements in Eingriff kommt.

4. Tank (100) mit mehreren Betonelementen (103) die zusammengegossen sind, wobei die Betonelemente senkrecht vorgespannt sind und waagrecht eingebettete Rohre (42) aufweisen, die waagrechte Vorspannungskabel (43) enthalten, wobei die eingebetteten Rohre und die Fugen zwischen den nebeneinander angeordneten Betonelementen mit Fugenbeton ausgefüllt sind, wobei der Tank **dadurch gekennzeichnet ist, dass** die Betonelemente so ausgebildet sind, dass jede der Fugen einen mit Beton gefüllten Fugenzwischenraum aufweist, der neben den die Vorspannungskabel (43) enthaltenden waagrechten Rohren einen Hohlraum (41) aufweist, in den der Fugenbeton gefüllt wurde, und in jedem mit Beton gefüllten Fugenzwischenraum der Abstand zwischen zwei nebeneinander angeordneten Betonelementen an dem Hohlraum größer als an den waagrechten Rohren ist.

Revendications

1. Élément en béton (103) pour un réservoir (100), ledit élément comprenant des tubes horizontaux incorporés (42) disposés de façon à recevoir des câbles de précontrainte (43), dans lequel ledit élément est formé de telle sorte que, lorsque deux éléments sont positionnés côte à côte, un espace de jointure destiné au coulage des deux éléments ensemble est ménagé entre eux,
caractérisé en ce que
ledit espace de jointure comprenant une cavité (41) à côté desdits tubes horizontaux (42), pour soulever le béton de jointure et abaisser un tuyau de remplissage, **en ce que** dans ledit espace de jointure la distance entre les deux éléments en béton étant supérieure au niveau de ladite cavité qu'au niveau desdits tubes horizontaux (42).

2. Élément en béton selon la revendication 1, dans lequel des dispositifs de scellement (40), de préférence des bandes de compression préalablement comprimées, sont positionnés dans les parties extérieures dudit espace de jointure.

3. Élément en béton selon la revendication 1 ou 2, dans lequel un côté dudit élément comprend un évidement et un côté opposé dudit élément comprend une partie saillante, lesquels côtés sont formés de telle sorte que, lorsque deux éléments sont positionnés côte à côte, la partie saillante de l'un des éléments s'engage dans l'évidement de l'autre élément.

4. Réservoir (100) comprenant une pluralité d'éléments en béton (103) coulés ensemble, lesdits éléments en béton étant préalablement étirés verticalement et comportant des tubes incorporés horizontalement (42) contenant des câbles de précontrainte horizontaux (43), lesdits tubes incorporés et les jointures entre les éléments en béton, positionnés côté à côte, étant remplis de béton de jointure, ledit réservoir étant **caractérisé en ce que** lesdits éléments en béton sont formés de telle sorte que chacune des jointures comporte un espace de jointure rempli de béton et comprenant une cavité (41) à côté desdits tubes horizontaux contenant des câbles de précontrainte (43), dans laquelle ledit béton de jointure a été introduit et, dans chaque espace de jointure rempli de béton, la distance entre deux éléments en béton adjacents est supérieure au niveau de ladite cavité qu'au niveau desdits tubes horizontaux.

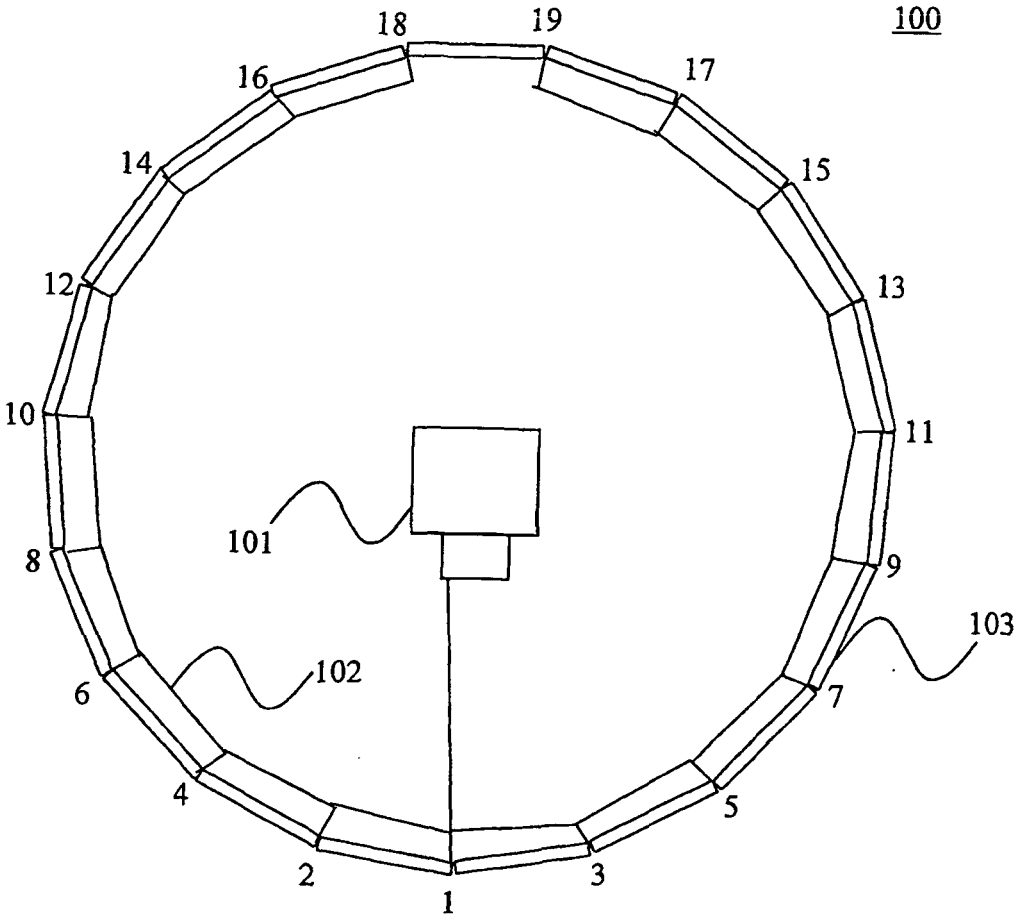

FIG. 1

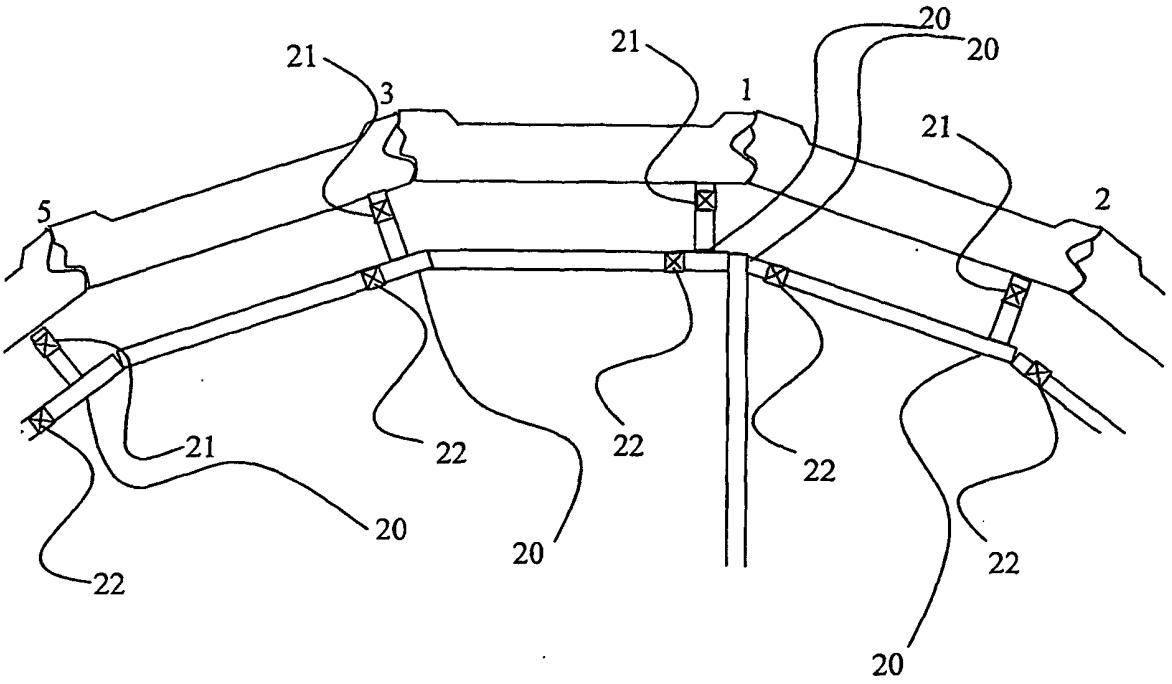

FIG. 2

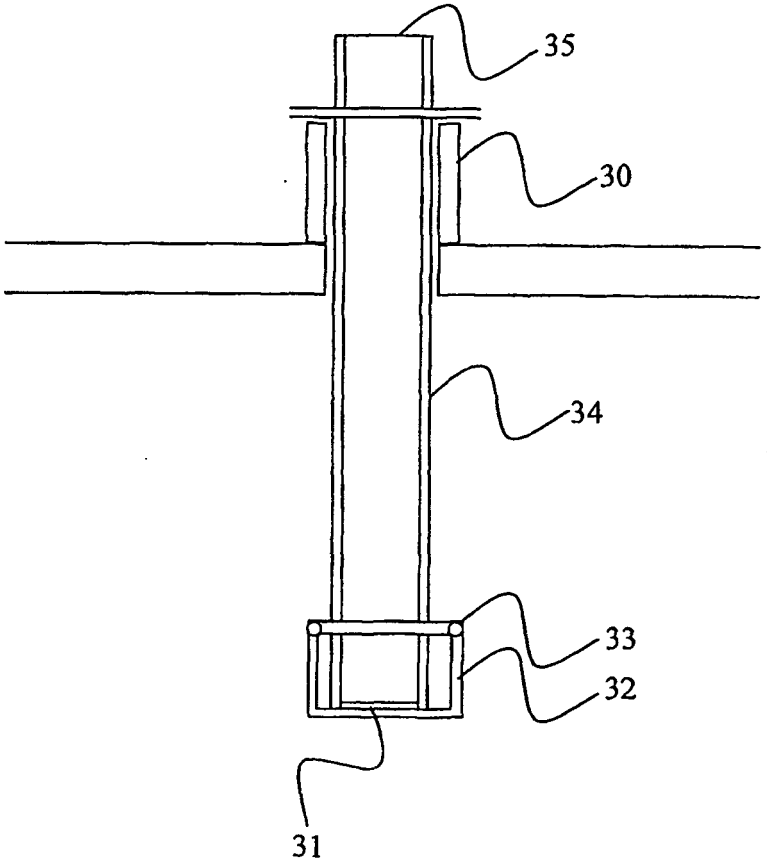

FIG. 3

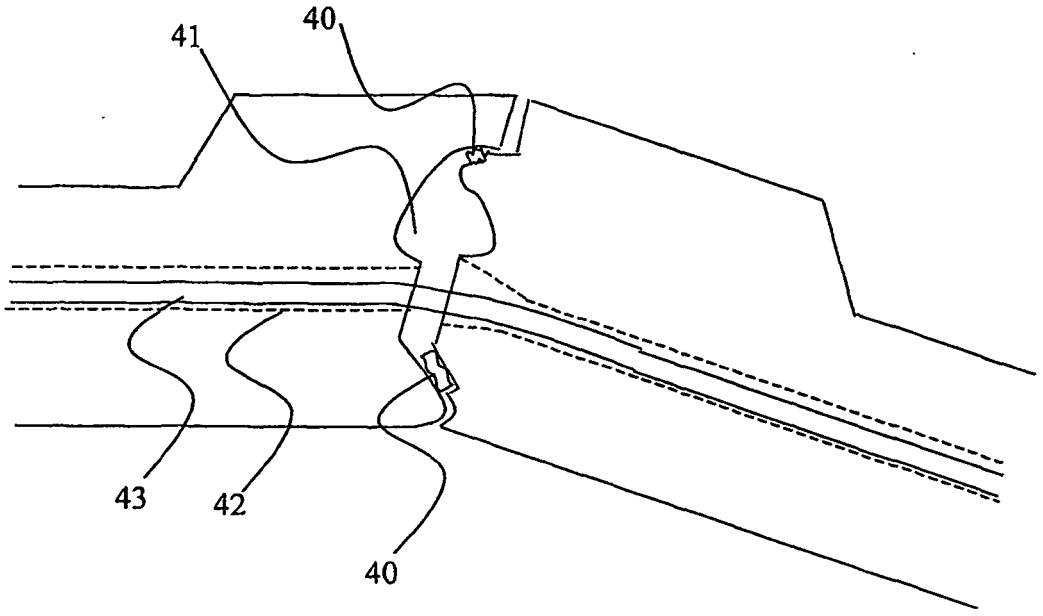

FIG. 4

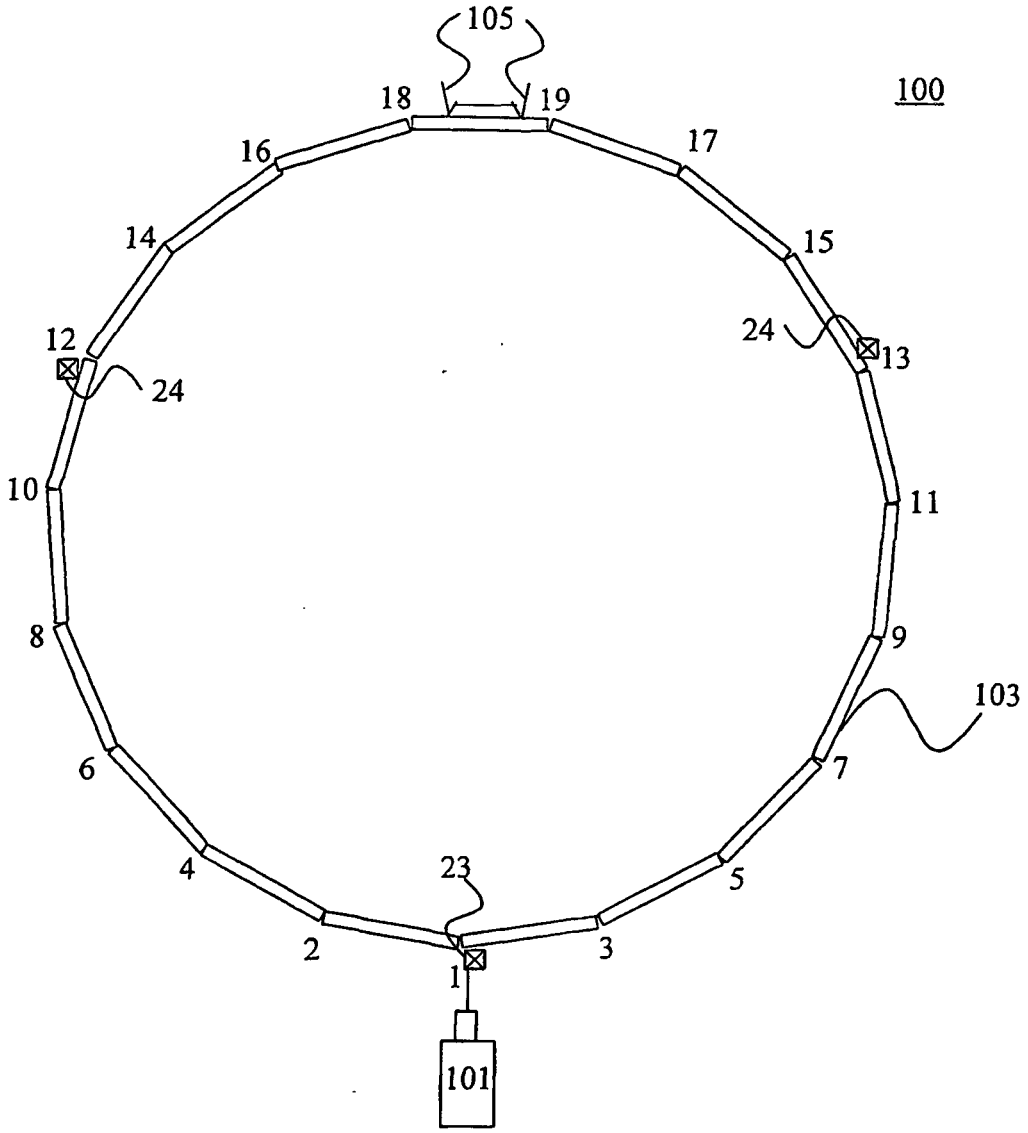

FIG. 5